IV. FUNCTIONAL ACCOMPLISHMENTS

The hydrologic conditions and the reservoir regulation described in the preceding two chapters have produced significant effects on many aspects of life in the Pacific Northwest. These effects are discussed and quantified within the following benefit categories: flood control, energy generation, irrigation, navigation, recreation, water quality, and fishery operation. These discussions are not intended to be thorough or complete but are cursory and contain only the salient features. For more information contact either the appropriate agency whose Water Management Group members are listed inside the back cover of this report or contact the Water Management Group officers, also listed inside the back cover.

A. FLOOD DAMAGES

The effect of reservoir regulation on downstream river flow is determined by routing (the calculation of travel time, diversions, etc) and comparing regulated and unregulated (*ie* natural or pre-project) flows. The flood damages given in Table 20 are for selected sites associated with reservoir flood control operation and show both the observed flows and damages and the unregulated flows (those that would have been observed without the flood control dams) and the damages prevented (the additional damages that would have occurred without the flood control reservoir operation). The reduction in the river stage or flow that resulted from the reservoir regulation was used to index the value of damages prevented. This year both the observed and prevented damages in northwestern Oregon were difficult to determine because of the multiple floods that occurred in the same locations and the damages from the earlier floods that were still unrepaired at the time of the subsequent flood events.

The flood damage prevented by reservoir operation in the Northwest was $4,290,956,000. Damages prevented in the Willamette Basin constituted 91% of this total and nearly 9% of the total was in the Snake Basin and one-third of the latter in the Boise sub-basin. The high damage prevention in Idaho was due to above normal spring precipitation and short warm spells causing slow snowmelt of a near record snowpack in the upper and middle Snake River Basin. Some of the damages prevented in the Upper Snake Basin result from new development in the flood plain near Jackson, Wyoming.

The Willamette Basin damages prevented were attributed to three rainstorms: mid November, New Year's, and the beginning of February. On the mainstem Willamette River flow reductions were 45-63% during the November event, and 30-36% during the other two events. The fact that no observed damages are listed for the Willamette Basin may be deceptive because of the unrepaired damages from the February 1996 record flood that still existing at the time of the November event. However, the operation of the Willamette Basin flood control projects the damages prevented totaled $3,912,321,000.

Table 21 is a tabulation of damages prevented by major flood control projects in the Columbia Basin for the period since 1948 through 1997. Damages prevented for the lower Columbia and for the entire basin represent the damage for the cost and development of the year of occurrence. At today's cost and development level, the amounts in past years would be much larger. The damage prevented by control of winter floods on tributary streams is not shown.

B. ELECTRIC ENERGY

Power operations in this report reference two major

Table 20

SUMMARY OF FLOOD DAMAGE OBSERVED AND PREVENTED
Columbia River and Tributaries

POINT	RIVER	UNREGULATED [1] Flow (kcfs)	UNREGULATED [1] Stage (ft)	UNREGULATED [1] Date	OBSERVED Flow (kcfs)	OBSERVED Stage (ft)	OBSERVED Date	CALCULATED DAMAGES $1000 Obs'vd	CALCULATED DAMAGES $1000 Prev'd [2]
Bonners Ferry, ID	Kootenai		79.9	May 18		64.4	May 17	0	58,268
Columbia Falls, MT	Flathead	101.6		May 17	59.9		May 17	3,953	20,067
Hope, ID	Pend Oreille		2068.3	Jun 8		2062.7	Jun 4	1,060	2,332
Newport, WA	Pend Oreille	159.4		Jun 8	138.2		Jun 5	5,512	12,296
Cle Elum, WA	Yakima	13.9		May 14	7.9		Jun 1	0	257
Parker, WA	Yakima	38.6		May 15	19.0		May 15	800	9,056
Flat Creek, WY	Snake	36.1		Jun 5	29.9		Jun 11	85	18,136
Heise, ID	Snake	58.5		Jun 11	42.5		Jun 14	0	1,678
Shelly, ID	Snake	72.9		Jun 7	47.6		Jun 16	6,692	45,900
Carey, ID	Little Wood	1.3		Jan 2	.92		Jun 11	532	102
Boise, ID	Boise	22.0		May 18	7.2		Mar 22	0	120,528
Owyhee, OR	Owyhee	31.6		Jan 3	4.2		Jan 9	0	2,707
Emmett, ID	Payette	27.3		May 18	18.8		Jan 3	0	1,898
Weiser, ID	Snake	154.6		Jan 3	81.8		Jun 3	0	29,733
Spalding, ID	Clearwater	127.5		May 17	80.7		May 17	0	2,099
Lower Granite, WA	Snake	357.9		May 17	225.3		May 18	0	5,244
The Dalles, OR[3]	Columbia	897.9		Jun 7	570.7		Jun 15		
Vancouver, WA	Columbia		28.4	Jun 8		21.6	Jan 3	0[4]	48,334
					COLUMBIA BASIN SUBTOTAL			63,014	378,635
Salem, OR	Willamette	272.2		Nov 21	167.0		Jan 2	0[4]	3,912,321
							GRAND TOTAL	63,014	4,290,956

[1] In the Columbia River Basin, flows are those which would have resulted without regulation by Mica, Libby, Duncan, Arrow Lakes, Hungry Horse, Flathead, Noxon Rapids, Pend Oreille, Grand Coulee, Chelan, Jackson Lake, Palisades, American Falls, Dworshak, run-of-river projects, Grand Coulee pumping, and major irrigation diversions in the Snake and Yakima River Basins.

In the Willamette and western Washington Basins, flows are those which would have resulted without regulation by Hills Creek, Lookout Point, Falls Creek, Cottage Grove, Dorena, Fern Ridge, Blue River, Cougar, Detroit, Green Peter, Foster, Howard Hanson, Mud Mountain, Wynoochee, and Mossyrock Projects.

[2] Damages prevented are those prevented by reservoirs and diversions noted above. Additional damages prevented by levees and channel improvements are not included in the prevented amounts. Observed damages in uncontrolled tributaries are not included.

[3] Damages are included in the Vancouver, WA values.

[4] Observed damages from the November 1996 flood were not determined because of overlapping damages from the February 1996 flood that in many cases were not repaired prior to the November event.

entities: the Coordinated System and the Federal Columbia River Power System (FCRPS). The former includes most of the generating facilities, hydro and thermal, in the Pacific Northwest, including the FCRPS projects, which are Federally owned (Appendix A). There are three major operational thermal plants in the Northwest. Each of these plants contribute a portion of their output, through contractual arrangements or Federal financing, to the Federal System. The nuclear plant is Washington Public Power Supply System nuclear power plant #2 (WNP-2). The fossil fuel plants are Centralia and Boardman. Although participants of the Coordinated System operate their own reservoirs, the power system is operated as a one-owner system to optimize both energy

Table 21

EFFECT OF RESERVOIR REGULATION ON FLOOD PEAKS AND DAMAGES
Columbia River Basin

Water Year	Max Annual Mean Daily Peak[1] The Dalles (kcfs)		Damages Prevented ($1 million)		Water Year	Max Annual Mean Daily Peak[1] The Dalles (kcfs)		Damages Prevented ($1 million)	
	Unreg	Obsrv	Lwr Col[2]	Col Bsn[3]		Unreg	Obsrv	Lwr Col[2]	Col Bsn[3]
1948	1010	1010	*	*	1976	637	419	15.65	43.08
1949	660	624	0.67	*	1977	276	183	0.00	0.00
1950	823	744	9.80	*	1978	565	313	6.00	30.61[4]
					1979	482	306	1.50	4.65
1951	672	602	0.80	*	1980	544	341	5.16	15.26[R]
1952	579	561	0.34	*					
1953	672	612	1.18	*	1981	579	436	10.91	45.26[R]
1954	590	560	0.26	*	1982	759	422	15.22	78.62
1955	614	551	0.62	*	1983	732	400	18.48	131.00[R]
					1984	628	376	10.71	107.29
1956	940	823	25.00	37.67	1985	550	274	10.45	23.46
1957	820	705	6.60	11.11					
1958	735	593	3.55	7.83	1986	719	388[R]	0.24[R]	72.06[R]
1959	642	555	0.88	2.6	1987	439	284	0.00	9.09
1960	493	470	0.08	0.58	1988	342	236	0.00	2.74
					1989	512	312	6.30	37.10
1961	789	699	6.50	7.7	1990	511	372	1.66	15.75
1962	503	460	0.09	1.79					
1963	481	437	0.03	0.65	1991	568	348	2.64	101.16
1964	764	662	7.60	22.91	1992	328	232	0.00	0.71
1965	669	520	1.44	7.18	1993	602	382[R]	0.00[R]	81.37
					1994	381	224	0.00	11.74
1966	455	396	0.00	0.43	1995	552	296	0.03	61.54
1967	781	622	14.21	20.80					
1968	533	404	0.26	1.07	1996	719	456	4.32[R]	227.03[R]
1969	628	449	2.61	5.51	1997	898	571	48.33	378.64
1970	634	429	1.16	6.34					
1971	740	557	8.49	25.76					
1972	1053	618	213.10	260.49					
1973	402	221	0.00	0.52					
1974	1010	590	239.73	306.36					
1975	669	423	9.41	40.97					

[1] Observed discharges are preliminary values calculated from project data. [2] Damages are for the Columbia River below McNary Dam. [Dollar values are for the year of the flood. Willamette excluded.] [3] Totals are damages prevented by major projects above The Dalles during the spring and summer runoff. Damages prevented in Canada and/or by levees and channel improvements are not included.
[4] Damages are based on the flood of December 1977. [R] Revised

Table 22

END OF MONTH ENERGY STORAGE - thousand MWh

MONTH	COORDINATED SYSTEM			CANADIAN TREATY		
	ORC/PDP	Actual	Difference	ORC/PDP	Actual	Difference
Aug 96	58.5	58.8	0.3	22.5	22.2	-0.3
Sep 96	55.6	55.4	-0.2	21.8	20.8	-1.0
Oct 96	53.0	51.8	-1.2	20.5	19.4	-1.1
Nov 96	49.3	47.4	-1.8	18.2	17.4	-0.8
Dec 96	43.1	40.7	-2.4	15.0	14.4	-0.6
Jan 97	27.9	29.5	1.6	7.8	8.3	0.5
Feb 97	17.1	19.5	2.4	3.3	4.2	0.9
Mar 97	12.7	15.1	2.4	1.0	2.1	1.1
Apr 97	13.6	16.1	2.5	0.3	2.8	2.5
May 97	38.2	39.9	1.7	6.7	8.5	1.8
Jun 97	58.1	57.5	-0.6	17.8	17.7	-0.1
Jul 97	62.0	62.0	0.0	22.0	22.0	0.0
Aug 97	58.5	57.8	0.7	22.5	21.9	-0.6
Sep 97	55.7	56.2	0.5	21.6	21.4	-0.2

Table 23

SOURCES OF BPA ENERGY

SOURCE	AMOUNT (MWh)	PERCENT
COE*	69,768,247	66.2
USBR*	27,194,094	25.8
THERMAL	6,838,779	6.5
MISC.	1,535,279	1.5
TOTAL	105,336,399	100.0

* Hydroelectric energy

production and management of the other water resources in the Pacific Northwest.

1. <u>Generation</u>

The Coordinated System storage level at the beginning of the 1996-97 operating year was 99.5% full which resulted in the System adopting first year Firm Energy Load Carrying Capability (FELCC) from the critical period studies. Due to above average streamflows throughout the year, the system generally operated to the Operating Rule Curve (ORC) or flood control for the entire period, producing large amounts of surplus energy. The system storage energy reached 99.1% full on July 31,1997, and the System adopted the FELCC from the 1997-98 PNCA Final Regulation study. Table 22 shows the status of energy stored in the Coordinated System at the end of each month in the 1996-97 operating year compared with the ORC or Proportional Draft Point (PDP) where applicable. Normal full Coordinated System reservoir energy content is approximately 63,700 MW-mo.

Table 23 shows the breakdown of Federal generation between the Corps, Reclamation, thermal, and miscellaneous energy sources. Also tabulated are the percentage changes over the operating year. The Corps' portion changed by 0.7% and Reclamation's by -3.0%.

Thermal generation decreased by +12.7% while miscellaneous generation changed by -4.3%. Of the Federal energy marketed by BPA, the Corps continues to generate two-thirds of the total and Reclamation continues to generate one-fourth.

Table 24

HISTORICAL POWER PURCHASES
in millions of dollars

YEAR	BUY	YEAR	BUY
FY97	$39	FY90	$11
FY96	$55	FY89	$93
FY95	$155	FY88	$20
FY94	$207	FY87	$3
FY93	$216	FY86	$1
FY92	$137	FY85	$10
FY91	$21		

Note: Purchases do not include storage costs.

2. Marketing

Fiscal year 1997 was a record year for bulk power sales. The fact that it was one of the highest water years in the historic record, coupled with a reduction in firm loads produced substantial surplus energy during the water year. Even during the fall and winter months streamflows were high enough to support large surplus secondary energy sales throughout the period. Table 24 lists FY 97 purchases in relation to those for the past 12 years. The FY 97 purchases were kept to a minimum due to above normal precipitation and streamflows. Table 25 specifically shows the continuous sale of surplus and nonfirm energy that picked up in the fall and continued through the spring.

Table 25

ENERGY PURCHASES AND SALES BY MONTHS
(MegaWatt-hours)

Mo/ Yr	Purchases	TO NORTHWEST UTILITIES		TO SOUTHWEST UTILITIES	
		Nonfirm	Surplus Firm	Nonfirm	Surplus Firm
Aug 96					
Sep					
Oct	231	257	1678	243	1041
Nov	279	59	1236	64	868
Dec	198	75	2440	47	1127
Jan 97	160	1042	2828	288	1159
Feb	318	1150	2949	481	898
Mar	291	644	3523	841	1421
Apr	443	179	3304	402	1904
May	311	265	3178	562	2106
Jun	96	358	3145	258	2533
Jul	334	233	2700	200	3028
Aug	*184*	*63*	*2024*	*60*	*3019*
Sep	*251*	*17*	*1745*	*5*	*1763*
TOTAL	3096	4342	30,750	3451	20,867

*Includes scheduled and non-scheduled utilities. Data in *italica* are preliminary

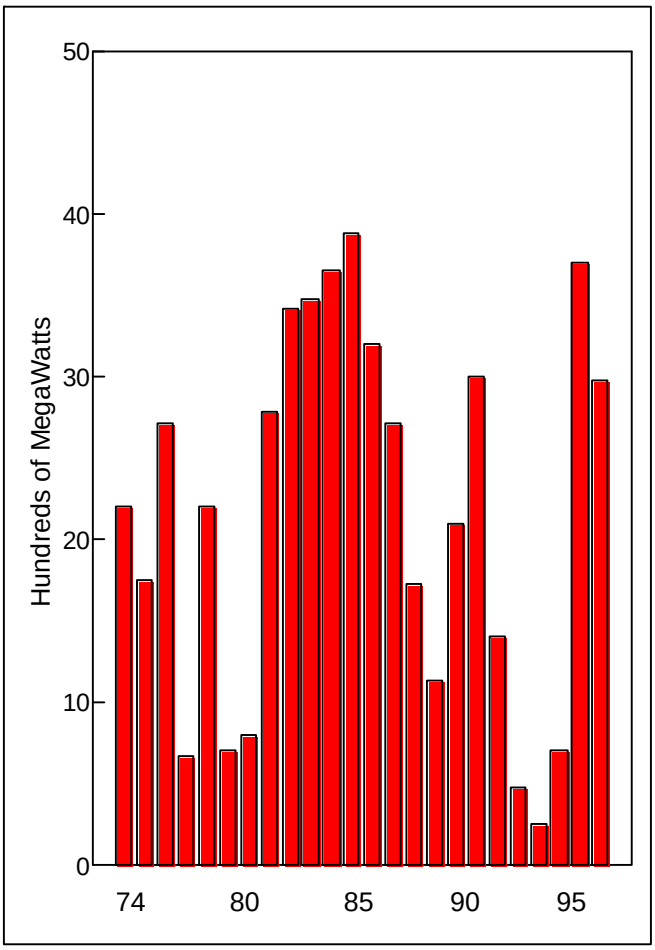

Figure 13. **1996-97 CAPACITY OF THE NW-SW INTERTIE IN MW**

This was a year of adjustment for BPA as the Transmission and Power Businesses were functionally split into two organizations in accordance with the FERC rulings. By mid March 1997, the Power Business Line was consolidated all at one location in Portland, and the Transmission Business Line was consolidated and located at the Dittmer Control Center in Vancouver, Washington.

3. Northwest-Southwest Intertie

Much of the year was spent reviewing combined Operational Transfer Capacity of the California-Oregon Intertie and the Pacific DC Intertie as a result of the July and August 1997 outages. Figure 13 displays the fluctuation in the total capacity available over the fiscal year. Frequently, the sum of the individual capacities of the AC and DC lines were restricted by the combined transfer limits set by the Western States Coordinating Council. In real time operation, the reductions in the capacity ratings led to more frequent problems with unscheduled flow (also known as loop flow) throughout the summer and fall. Unscheduled flow is governed by the law of physics that causes power from a given source to flow over all possible paths to its destination. To allow for unscheduled flow, further reductions in the rated capacity of the Intertie were necessary, calling for widespread reduction of southbound energy deliveries.

4. Industry Changes

Sweeping changes in the West Coast energy market began in late 1997 with the signing of California Law AB1890, calling for deregulation of California's investor-owned electric utilities (IOUs), and opening the state's

Table 26

FERC LICENSE ACTIVITY BY STATE

ACTION	WA	OR	ID	MT	WY	TOTAL
Licenses	60	24	45	8	3	140
License Applications	20	2	2	0	0	24
Exemptions	19	22	66	4	1	112
Exemption Applications	0	1	0	0	0	2
TOTALS	99	48	113	12	4	276

$21 billion electricity market to competition. In 1997, the California Independent System Operation (ISO) and Power Exchange (PX) were created, marking the beginning of this new era. BPA planned to meet these new market challenges by working to certify as an ISO scheduling coordinator and to certify as a PX participant to market surplus energy in California. The development of new electronic trading, scheduling, account tracking and settlement tools with these emerging market entities was also initiated in 1997. BPA will transition from conducting a five days per week prescheduling of energy and transmission to prescheduling seven days per week. Energy trading and transmission acquisition functions are expected to move to a 7-day per week, 24-hour per day basis within the next year to keep pace with industry changes as they unfold.

5. Energy Licensing and Regulation

As of the end of the water year, the Federal Energy River Regulatory Commission (FERC) had a total of 140 outstanding licenses and 112 exemptions in the Columbia River Water Management Group area, which FERC's Portland Regional Office staff inspects for compliance with its dam safety program and other terms and conditions of project authorization. Also, 24 applications for license or exemptions involving new hydropower capacity were pending within the area. In all, the Commission has 276 projects under its supervision in the area, consisting of either outstanding licenses, exemptions issued, or applications for license. Table 26 is a breakdown of these categories by state.

Construction inspections were conducted at 23 projects at which construction was underway during the reporting period. New generating capacity under construction represents approximately 10 MW of energy that is now or will be marketed by either BPA, licensed utilities, or directly used by the hydropower developer.

C. IRRIGATION

Irrigation service from Bureau of Reclamation projects was available to an estimated 2,870,000 acres. Of that total, actual irrigation deliveries were made to approximately 2,735,000 acres. The water came from 52 reservoirs with an active capacity of about 10,090 kaf. This does not include 8,214 kaf of storage in Franklin D. Roosevelt Lake (behind Grand Coulee Dam) and Hungry Horse Reservoir in western Montana. Record high deliveries were made to farms in 1970 and 1974.

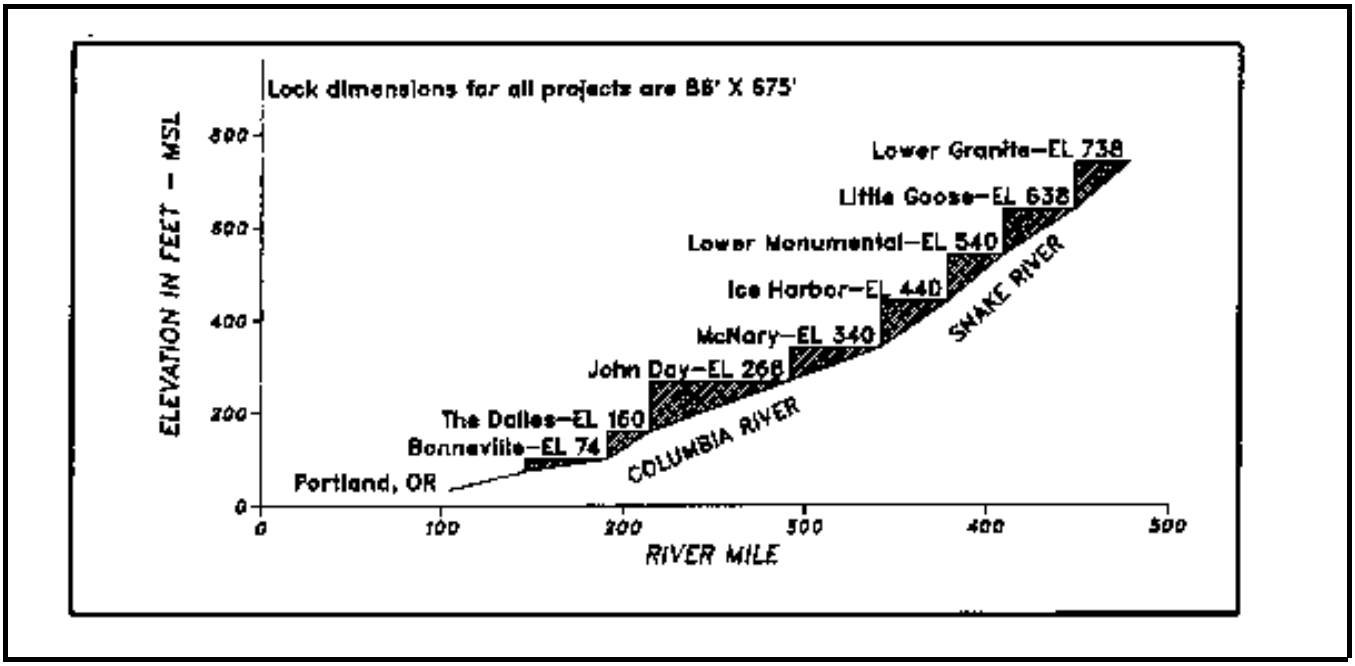

Figure 14. **PROFILE OF LOWER COLUMBIA AND SNAKE RIVERS**

D. NAVIGATION

The Corps of Engineers operates navigation locks on three waterways in the Pacific Northwest: the Columbia-Snake River Inland Waterway in Washington and Oregon, the Willamette Falls Lock in western Oregon, and the Lake Washington Ship Canal in Seattle. The Columbia-Snake River Inland Waterway, Figure 15, extends 465 river miles from the Pacific Ocean to Lewiston, Idaho. The waterway has the capability of providing safe passage for ocean-going vessels up to Vancouver, Washington, and Portland, and for shallow-draft tugs, barges, log rafts, and recreation boats to Lewiston.

Navigation on the Columbia River from Portland to Pasco, Washington, is made possible by four locks that elevate the river from 8 ft mean sea level (msl) below Bonneville Dam 42 miles east of Portland to 340 ft msl in McNary Reservoir. This latter pool extends to Pasco on the Columbia and to Ice Harbor Dam on the Snake River. Navigation on the Snake River from its confluence with the Columbia near Pasco, to Lewiston, is made possible by four locks which elevate the river from 340 ft at Ice Harbor Dam to 738 ft in the Lower Granite reservoir. The nominal dimensions of all locks are 86 ft wide and 675 ft long. All the locks were closed simultaneously during March for annual maintenance.

Navigational flow requirements on the Columbia and Snake rivers were met by streamflows and pool levels determined from other project requirements. Cargo was generally transported without any special operational requirements, although occasionally some unusual navigation requirements demand special regulation. However, these special requirements did not generally alter the Columbia River regulation enough to have a significant effect on other project purposes.

The special project operations were necessary to meet navigational requirements during this year had to do with vessel groundings, emergency operation at projects, and for transportation and off loading of decommissioned defueled submarine nuclear reactor cores at Hanford, Washington. The latter special operations were required at both upstream and downstream projects to hold the McNary pool at a constant elevation during the several hours required to off load the reactor cores.

Commercial cargo through the Columbia-Snake locks consist chiefly of gasoline, jet fuel and kerosene, diesel fuel, fertilizers, grain, and logs. More cargo, mostly grains, was hauled down river than was hauled upstream. March tonnages were less than other months on the Snake and lower Columbia due to the annual closure for maintenance. The Willamette Falls Lock Project, located on the Willamette River at Oregon City, transports vessels and cargo around the 40-foot high Willamette Falls. This lock, with four locking chambers, is used mainly by sand and gravel barges and by wood products shippers. Efforts to rebuild the locks with a single chamber have never been funded.

The Lake Washington Ship Canal Project provides ship access between the saltwater of Puget Sound and the freshwater of Salmon Bay, Lake Union, and Lake Washington. The major cargo through the locks was sand, gravel, and wood products. However, because of its proximity to the heart of Seattle the majority of its lockages were for pleasure craft, especially in the summer. A large portion of the Seattle commercial fishing fleet, consisting of trawlers and gillnetters, is moored in Salmon Bay, immediately above the locks. During the commercial fishing season these vessels are major users of the locks. Tour boats and government vessels, especially NOAA vessels based on Lake Washington, and Coast Guard vessels moored above the locks, also use the locks.

E. RECREATION

Although many agencies provide recreational facilities, the only agencies to also have project operational activities are the Corps of Engineers and the Bureau of Reclamation. These operational activities include not only those activities for which the projects were authorized but also those ancillary activities which benefit the public without adversely impacting the authorized operations. The added benefits include maintaining some reservoirs within certain elevation ranges throughout the recreation season while at other projects it may be regulating downstream discharges for the activities. Recreational activities include boating, fishing, sailing, hunting, rafting, wind surfing, hydroplane racing, and cross channel swimming. In some cases, the reservoirs are maintained at high elevations during the camping and picnicking season for aesthetic reasons.

Historically, the Corps and Reclamation use different methods to count visitation-days and consequently they could not be directly compared. Now both agencies will be using the visitor-hour/visitor-day method. The difference in the two systems used in the past was that a recreation-day equaled a visit by one person to an area for all of or any part of a 24-hour day; whereas a visitor-hour equated to actual time spent on an area. Twelve visitor-hours equals one visitor day.

1. Corps of Engineers

Recreation use at Corps administered water resource projects was an estimated 9.0 million 12-hour visitor-

days, or 110 million visitor-hours. Although the continuing drought conditions in the Northwest affected the use of certain recreation facilities and reduced water surface area, visitation to Corps projects was nearly the same as last year.

The high volume of runoff this year at Libby assured a full pool that increased recreational usage of the lake and tourist facilities. A high runoff volume also occurred at Dworshak but the early drawdown for the grouting contract limited the water contact recreation.

The total capital investment in recreation development is over $45 million which generates significant benefits each year. Three Corps projects exceeded half-million visitor-days of use and one project, Bonneville Dam, exceeded 1 million visitor-days.

Sightseeing continues to be the leading recreation activity. Facilities such as visitor centers, overlooks, and interpretive facilities are provided to accommodate this use. Swimming, boating, fishing, and general day use activities are other recreational opportunities sought by visitors to Corps projects. Wind surfing, particularly on the Columbia River projects, has become a highly visible activity over the past several years.

2. Bureau of Reclamation

Reclamation reservoirs provide water-based recreation opportunities unique to the surrounding areas in some of the more arid portions of the region. Reclamation's Pacific Northwest (PN) Region has 79 recreation areas on 66 reservoirs, providing 395,000 acres of water surface and 2,400 miles of shoreline. Reclamation works cooperatively with state, county, irrigation districts, and federal agencies, as well as private concessionaires in developing and managing many of the recreation areas at Reclamation reservoirs. Recreation facilities include 6,250 campsites in 148 campgrounds; 150 picnic areas; 39 swimming beaches, and 196 boat launch ramps. Recreation facilities are evaluated in terms of visitor safety and accessibility and improved as needed.

This recreation season was successful for water dependent recreation activities. Visitor data has not been measured for the past three years. Given the excellent water conditions it is assumed that recreation use remained at the 10.5 million 12-hour visitor day level as reported in 1992.

The Title 28 Program provides a 50% cost share with non-Federal management partners for construction of new recreation facilities or rehabilitation of existing facilities. The PN Region received $1,148,000 for 19 new or ongoing recreation and fish and wildlife projects in Idaho, Oregon, and Washington. These projects improved accessibility and visitor safety, increased facility capacity, enhanced recreation opportunities, and fish and wildlife benefits.

- Reclamation cost shared, with Washington County, Oregon, to construct a group picnic pavilion and make site improvements at Henry Hagg Lake (Scoggins Dam).
- Reclamation cost shared with Bonneville County, Idaho, at Ririe Reservoir to upgrade Juniper Campground and Blacktail Park. Improvements included expanding parking facilities to provide safe turn-around areas for boaters, installing a water and sewer system and electric power to 50 camp spurs.
- Reclamation cost shared with the Yakima Indian Nation to move an existing high-voltage power line away from fish acclimation ponds, installation of gravity-flow water supply and additional fish rearing pond.

The PN Region continued to support the Catch A Special Thrill (C.A.S.T.) program through three events. The children invited range in age from 7-16 years old and have a variety of physical or developmental disabilities or in some cases, a terminal illness. The Snake River Area Office sponsored its 5th annual C.A.S.T. event at Black Canyon Park on September 13th; Upper Columbia Area Office sponsored its 6th annual C.A.S.T. event at Steamboat Rock State Park in eastern Washington on August 16th; and the Lower Columbia Area Office sponsored its 2nd annual event at Henry Hagg Lake west of Portland, Oregon on September 7th.

Reclamation issued a final Environmental Assessment and Finding of No Significant impact for the Scattered Tracts Resource Management Plan (RMP) which addresses Reclamation's future management of almost 90,000 acres within the Columbia Basin in Washington. The RMP was developed through a process of public and agency involvement as required by the National Environmental Policy Act. This process was initiated in April 1992 and continued throughout the planning process. The preferred alternative proposes the disposal of 11,687 acres of publicly held lands within the Columbia Basin. In addition to 31,891 acres retained for project purposes, 37,467 acres will be retained for various resource values, and 8,474 acres placed in a Aland trust@ for potential future development.

F. WATER QUALITY

Project operations-related water quality activities were conducted by the Corps of Engineers and the Bureau of Reclamation. Activities included checking for compliance with applicable federal and state water quality standards and regulations and determining the affects on

stream productivity, especially related to anadromous fish. The majority of these activities were carried out during the juvenile fish migration season.

1. <u>Dissolved Gas</u>

The Columbia/Snake River Total Dissolved Gas Monitoring Program is an annual continuing activity since 1984 with the primary objective to collect real-time dissolved gas and water temperature data for use in reservoir regulation. This data is collected as a priority during the anadromous fish migration season (April-August) and as a second priority outside of the endangered species migration period. The collecting and transmitting of real-time dissolved gas and water temperature data was the responsibility of the individual Corps Districts, Reclamation, and other participating agencies. The Corps' Division staff continued to coordinate the system-wide monitoring program and prepare periodic reports. All data were ultimately stored in the Division's Water Quality Master computer file.

This year's program operated from mid-April through mid September for most stations. A total of 39 instrument sites were in operation, at various reservoir forebay and tailwater locations as shown in Figure 16. As requested by EPA and the state environmental qualities offices, year-round monitoring also occurred at several key locations, including International Boundary, Dworshak (tailwater), Lower Granite (forebay and tailwater), Ice Harbor (forebay and tailwater), McNary (two forebay stations and one tailwater station), Bonneville (forebay), and at Warrendale, Oregon.

All the data collection instruments were fully automated but used different methods for transmitting data. Most instruments were connected to individual data collection platforms that were programmed to collect data hourly and to transmit them every four hours via GOES telemetry. Instruments operated by the Corps' Walla Walla District were programmed to transmit hourly data directly to the District office via radio transmission and phone lines, and then to the Division via phone lines.

Figure 15. **LOCATION OF DISSOLVED GAS MONITORING STATIONS**

Data transmission from some of the PUD instruments was manually entered and sent via the Columbia Basin Telecommunications (CBT) system.

This data, along with pertinent reservoir and flow information, were posted on the Columbia River Operational Hydromet Management System (CROHMS) data base and displayed both on the Technical Management and the Portland District home pages. It was routinely used as a real-time basis for adjusting project spill in an attempt to control total dissolved gas levels to the state standards.

As was the case in the previous three years, NMFS required that spill be implemented at lower Columbia and lower Snake rivers mainstem dams to achieve an 80% fish passage efficiency (FPE). This requirement continued to be subjected to the State standards for total dissolved gas of 110%. At NMFS's request Idaho, Oregon, and Washington temporarily increased their TDG limits to 115% in the reservoir forebays and 120% in the tailwater areas in several installments (Table 27). The well above average runoff, combined with lack of energy market, triggered involuntary spill at a much greater level than that required in the BiOp during April, May and June. Average weekly flows at Lower Granite exceeded 160 kcfs during most of the April - June period. At McNary, average weekly flows were greater than 450 kcfs from late April through June, with peak runoff occurring in mid-June.

The resultant total dissolved gas exceeded 130% below several dams for extended periods during April through June, a situation similar to that of 1996. Tailrace areas that were most seriously affected were below Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary, John Day, and Bonneville (down to Kalama, Washingotn). This year, the number of days with total dissolved gas levels above 120% ranged from 60 at Lower Granite to 135 days at Ice Harbor (the most downstream of the Snake River dams) and from 42 days at Wauna Mills, Oregon, to 84 days at McNary. In the summer, the above-120% conditions persisted for a few days in July below McNary and Bonneville (Skamania, Washington). In the headwater areas, Dworshak released close to the maximum downstream channel capacity of 25 kcfs (including a spill of up to about 13 kcfs) during late April-early May and during July-August.

Average monthly and maximum instantaneous forebay dissolved gas were generally higher than those recorded in 1996 because of the higher runoff and spill, and also stayed at those high levels for longer periods. Most of the levels exceeding 130% saturation generally occurred at the same locations as last year.

2. Water Temperature

Monitoring of water temperature conditions throughout the Columbia and Snake river mainstem's was conducted in parallel to dissolved gas monitoring. Water

Table 27

GRANTING OF WAIVERS TO WATER QUALITY STANDARDS

GRANTOR	DATE GRANTED	PERIOD COVERED	PURPOSE
Oregon	Feb 28	Mar 3-23	Hatchery release
Washington	Feb 28	March 3-23	Hatchery release
Nez Perce Tribe	April 8	April 10 - August 30	Fish migration
Idaho	April 15	April 15 - June 1	Fish migration
Oregon	April 18	April 18 - August 31	Fish migration
Idaho	June 18	June 18 - July 15	Dworshak grouting
Idaho	July 24	August 18 - 31	Fish migration
Oregon	August 1	August 1 - 31	Emergency
Washington	August 8	August 1 - 31	Emergency

temperature measurements were taken at the same depth (about 15 ft) as the total dissolved gas sensors. In addition to surface water temperature, project personnel also collected water temperature data in the powerhouse scroll-cases on a daily basis. In some cases, water temperatures from the adult fishway collection system were also reported.

Water temperatures, which reflect air temperatures and streamflows, were generally slightly higher than in 1996 for most of the April-August period for the mid-Columbia, Snake and lower Columbia Rivers. The exception was the slightly lower water temperatures in April on the Snake and lower Columbia rivers.

A detailed report on the Dissolved Gas (and Water Temperature) Monitoring activities is prepared annually by the Corps.

3. Other Water Quality Activities

a. Reclamation. The primary emphasis of Reclamation water quality activities is to identify problems associated with management of operating projects and to develop appropriate corrective strategies.

! A water quality modeling study at Cascade Reservoir on the NF Payette River was completed. The two-dimensional BETTER model developed by the Tennessee Valley Authority, was used to evaluate in-reservoir management options, including selective withdrawal, a minimum pool for water quality protection, re-aeration, and bank stabilization. Reclamation worked closely with the city of McCall and others to help eliminate discharge of municipal waste water into the NF Payette River, and initiated implementation of storm water management measures. A monitoring program was also initiated to evaluate the effectiveness of constructed wetlands in reducing phosphorus loading associated with irrigation return flows to the reservoir.

! A series of outlet works release tests at Grand Coulee, to measure the effects of operation of the outlet works on downstream TDG, was completed. The outlet works, comprised of two tiers of 20 conduits each, discharge onto the downstream face of the spillway, and use a roller bucket dissipater. Test results indicated that upper and lower outlet works produced the same percent increase in TDG in the tailrace, and that the lowest TDG increases occurred when upper and lower level outlet works were operated in an over/under combination.

! The Burnt River Basin Water Temperature Modeling Study was initiated to develop a water temperature plan for the Burnt River basin. Stream temperature models will be used to simulate the instream cooling that result from riparian shading, existing reservoir storage, irrigation return flows, and other appropriate management practices are being considered in development of a temperature management plan.

! The joint water quality data gathering and modeling with the University of Idaho in the Middle Snake River area between Minidoka Dam and King Hill continued to provide baseline information on water quality and irrigation returns to the river for use in nutrient management planning, and evaluating impacts of the salmon migration flow augmentation program on threatened and endangered snail populations in the Snake River.

! Reclamation participated in multi-agency development of water quality management plans for the lower Boise and Payette rivers including a screening of potential irrigation waste water treatment and reuse sites, and the scoping of a demonstration reuse project.

! Injection wells near Minidoka, used for disposal of most irrigation return flows and storm water runoff, are subject to Idaho's increasingly stringent regulations for the quality of injected water. To eliminate the possibility of contamination of domestic wells, and due to EPA's designation of the Snake Plain Aquifer as a Asole source of drinking water@ under the Federal Safe Drinking Water Act, an alternative means of disposing of drainwater and stormwater, without use of injection wells, was implement.

! The reservoir water quality surveillance program focused on reservoirs suppling small projects in eastern Oregon provided chemical, physical, and biological data needed to manage water quality in Reclamation reservoirs and downstream releases. Information is stored on the EPA's STORET data base.

! Long-term water quality monitoring of irrigation supplies and returns continued on the Boise, Columbia Basin, Minidoka, and Yakima projects. Additional data was gathered for assessment of nonpoint source irrigation impacts in the Owyhee, Malheur, Powder, and Burnt basins.

b. Corps of Engineers

Portland District activities included the following:

! Flow and water temperature targets were again met for the Lost Creek and Applegate projects in the Rogue Basin resulting in very good spring and summer conditions for juvenile and adult migration. Routine water quality monitoring for nutrients and limnological parameters continued at both projects.

! In the Willamette Basin, at Cottage Grove Lake, water was sampled for mercury content to study the relationship between reservoir operations and mercury concentrations in the fish. There was also significant monitoring at Detroit Lake for turbidity because of the turbidity issues raised following the 1996 flood. At the City of Salem's request, the District drafted the pool to 25

ft below minimum power pool in an effort to reduce downstream turbidity. In other studies the volunteer water quality monitoring program continued at Fern Ridge reservoir; temperature monitors were placed in streams below Hills Creek to collect data for modeling the river, and routine surface-to-bottom profiling of reservoirs for limnological parameters continued during the spring and summer at all projects.

At Willow Creek Lake routine nutrient, methane, hydrogen sulfide and other limnological data were collected and other water quality studies with less impact on reservoir operation continued at numerous locations.

Seattle District activities included the following:

! Control of saltwater intrusion continued at the Hiram M. Chittenden Locks with the district monitoring saltwater intrusion into the ship canal using a series of real-time water quality sensors at six upstream stations enabling a quick response to slight increases in salinity before the salt water wedge reached Lake Washington. Various combinations of spill and saltwater drain openings were evaluated to study the efficiencies of saltwater control techniques. Mini-flushing, a low water use technique that removes saltwater from the lock chamber before it enters the ship canal, was not used this year due to concerns of fishery agencies

! A two-dimensional water quality model, CEQUAL-W2 developed by the Waterways Experiment Station (WES), was used to examine the effects of changes in Chittenden Locks operations on saltwater intrusion into the Lake Washington Ship Canal.

! The district is involved in continuing negotiations with the City of Seattle concerning a new set of instream flows for the Cedar River, a tributary of Lake Washington that supplies most of the inflow to the lake. These negotiations, which are part of a Habitat Conservation Plan (HCP), includes representatives from the Corps, National Marine Fisheries Service, and US Fish and Wildlife Service as well as state agencies and an Indian tribe.

! The district continued to monitor water quality at Wynoochee Dam, now owned by the City of Tacoma.

! At Howard A. Hanson Dam water quality studies continued on the possible impacts of increased summer conservation storage, selective withdrawals and downstream turbidity, while at Mud Mountain Dam sediment deposits in the reservoir and downstream turbidity continued to be evaluated.

Flood control at Libby Dam, with consideration also given to benefit for endangered Kootenai River white sturgeon and Snake River salmon stocks, dominated operations at Libby Dam. Numerous sturgeon eggs were found in the Kootenai River below Kootenai Falls, and one larval sturgeon was detected as a result of this operation.

Walla Walla Many water quality studies were conducted to support the Lower Snake River Juvenile Salmon Migration Feasibility Study (LSRFS). Individual studies included:

! Primary Productivity Study, to develop a model of the reservoir system macro and micro-habitat needed to assess the current carrying capacity.

! Sediment studies, to find the locations of the greatest percentage of fine material and to establish sediment particle distribution ranges for other studies.

! Baseline limnological study, a continuation of the same study initiated three years ago.

The District also conducted several normal O&M water quality programs as detailed below.

! At Lucky Peak Reservoir, water samples were collected for analysis and Hydrolab profiles were taken.

! At Mill Creek and Bennington Lake, water samples and limnological readings were taken and were analyzed for nutrients and chlorophyll a.

! At Dworshak regular water quality data collection continued on inflow streams, in the reservoir and in the river below the dam.

Temperature data was also collected from Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Reservoirs; the North Fork of the Clearwater, the Middle Fork of the Clearwater, and downstream of their confluence.

The WES team supporting DGAS continued to conduct extensive field research activities both prior to and during the fish passage spill season on the lower Columbia and lower Snake rivers as part of the Phase II Field Sampling Effort For the Gas Abatement Study (DGAS). Field sampling was conducted at Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary, John Day, The Dalles, Bonneville, and the tidal pool. Spillway TDG performance was studied at McNary and Bonneville under a wide range of operational conditions.

G. FISHERY OPERATIONS

Fishery operations were implemented in accordance with the Corps' Fish Passage Plan (FPP), which describes the manner in which the Corps' mainstem projects on the lower Snake and Columbia River will operate throughout the year to provide safe fish passage. This was in compliance with National Marine Fisheries Service (NMFS) Biological Opinion (BiOp) which contains other measures, including flow augmentation in the Columbia River,

Table 28

PROPOSED SPILL SCHEDULE FOR JUVENILE FISH PASSAGE
(daily averages)

	LWG	LGS	LMN	IHR	MCN	JDA	TDA	BON
Spring *% Spill*	*80*	*80*	*81*	*27*	*50*	*33*	*64*	*100*
Time of day	18-0600	18-0600	18-0600	00-2400	18-0600	18-0600	00-2400	00-2400
Summer % Spill	*0*	*0*	*0*	*70*	*0*	*86*	*64*	*100*
Time of day				00-2400		18-0600	00-2400	00-2400

* Bonneville daytime spills are limited to 75 kcfs to minimize adult salmon fall back and up to the 120% of spill capacity during the night.

Table 29

TARGET FLOWS FOR JUVENILE FISH PASSAGE

Week Ending	Lower Granite			McNary		
	Seasonal Target	Weekly Target	Actual Flow	Seasonal Target	Weekly Target	Actual Flow
4/6						
4/13	57.14	57.14	**84.93**	0.00	0.00	**251.94**
4/20	100.00	100.00	**108.46**	37.14	37.14	**263.40**
4/27	100.00	100.00	**172.07**	260.00	260.00	**395.17**
5/4	100.00	100.00	**160.57**	260.00	260.00	**426. 14**
5/11	100.00	100.00	**150.87**	260.00	260.00	**391.29**
5/18	100.00	100.00	**201.99**	260.00	260.00	**475.54**
5/25	100.00	100.00	**181.91**	260.00	260.00	**490.87**
6/1	100.00	100.00	**154.16**	260.00	260.00	**463.81**
6/8	100.00	100.00	**182.41**	260.00	260.00	**511.59**
6/15	100.00	100.00	**182.37**	260.00	260.00	**536.63**
6/22	87.14	87.14	**172.06**	260.00	260.00	**506.66**
6/29	55.00	55.00	**114.23**	260.00	260.00	**394.39**
7/6	55.00	55.00	**94.67**	208.57	208.57	**301.86**
7/13	55.00	55.00	**67.01**	200.00	200.00	**275.26**
7/20	55.00	55.00	**63.13**	200.00	200.00	**292.80**
7/27	55.00	55.00	**60.99**	200.00	200.00	**261.39**
8/3	55.00	55.00	**58.16**	200.00	200.00	**208.47**
8/10	55.00	55.00	53.23	200.00	200.00	**213.06**
8/17	55.00	55.00	48.74	200.00	200.00	**200.06**
8/24	55.00	55.00	41.90	200.00	200.00	**200.33**
8/31	55.00	55.00	36.23	200.00	200.00	185.51

Bold Actual Flows met or exceeded target flows. All flows in kcfs.

Table 30

ACTUAL SPILL OPERATIONS FOR JUVENILE FISH PASSAGE

	LWG	LGS	LMN	IHR	MCN	JDA	TDA	BON
Spring								
Avg Outflow (kcfs)	162.53	156.63	168.12	161.72	454.83	478.50	463.47	462.07
Spill Days	72	72	72	72	72	72	72	72
Avg Spill (kcfs)	58.96	60.22	64.53	92.89	289.41	161.47	298.38	254.07
% Spill	36.3	38.4	38.4	57.4	63.6	33.7	64.4	55.0
Spill days> 120%	50	49	57	68	71	68	48	70
Summer								
Avg Outflow	66.32	65.39	70.19	72.34	136.51	239.39	230.70	240.09
(kcfs)	37	13	18	72	62	62	62	62
Spill Days	4.5	3.53	3.87	40.62	77.88	46.1	146.82	100.32
Avg Spill (kcfs)	6.8	5.47	5.5	56.2	32.9	19.3	63.6	41.8
% Spill	3	1	3	13	0	1	0	4
Spill days> 120%								

Average daily spill in kcfs.

additional 427 kaf from the upper Snake River, in-season water management process, and operating the lower Snake River reservoirs at minimum operating pool (MOP) and John Day reservoir to the minimum level needed for irrigation pumping. In-season management of river operations was again provided by the Technical Management Team (TMT) while dispute resolution and policy guidance was provided by the Implementation Team (IT) and Executive Committee (EC) which are made up of representatives from the Corps, Reclamation, BPA, NMFS, USFWS, ODFW, WDFW, and IDFG. The State of Montana and CRITFC withdrew from the process.

1. Actual Operation

This year's well above normal runoff resulted in high levels of spill that created very high total dissolved gas (TDG) levels throughout the Columbia River system. These conditions raised several issues concerning spill and means of minimizing TDG, as well as other reservoir operations, flood control, use of storage for flow augmentation, including juvenile fish transportation and operation of collector projects, lower Snake River reservoir operation at greater than MOP, and for auxiliary water supply problems in the Bonneville Second Powerhouse adult fish passage facilities.

2. Spill for fish

The BiOp prescribed a spilling schedule, Table 28, and target flows, Table 29, at lower Snake and Columbia river projects that would provide a target fish passage efficiency (FPE) of 80% or more. This spill requirement was divided into spring and summer periods with the spring spill for the lower Snake River projects to run from April 10 to June 20 and the summer spill from June 21 to August 31. For the lower Columbia River projects spring spill ran from April 20 to June 30 and summer spill from July 1 to August 31. The spill requirements are shown in the table below. For most of the year, the TDG spill caps dictated the amount spilled.

As shown in Table 30, during the spring season the average daily spill ranged from 58 kcfs to 93 kcfs (36% to 57% of the daily flow average) at lower Snake River dams, and from 161 to 298 kcfs (34% to 63% of the daily flow average) at lower Columbia River dams. All these dams showed 72 days of spill in the spring. During the summer season, the average daily spill range was 4 to 41 kcfs (5 to 56% of daily average) for lower Snake River dams and 46 to 147 kcfs (19% to 64% of daily average) for lower Columbia River dams. Ice Harbor spilled continuously because of reduced hydraulic capacity; but the lower Columbia River dams spilled only for 62 days in summer. The Dalles spilled the most water for the year, followed by McNary and Bonneville.

3. Juvenile Fish Runs.

Salmonids are hatched either in hatcheries or in the

river (called wild fish) where they grow until their time for migration to the ocean. In some case, selected hatchery fry are placed in the river to grow in a natural setting before they beginning their in-river migration to the ocean. Some species begin their migration in the year of their hatching while others winter in the river before beginning their odyssey to the ocean.

During this travel time the juveniles are subject to many perils from predation from other fish and birds, spill at dams that can cause dissolved gas disease, physical injuries that may occur during dam passage, stress, diseases, and other problems. Depending upon the location in the basin of the hatcheries or redds the young fish will have to traverse up to nine dams on their out-migration. To help mitigate these dangers an alternate method of transportation has been developed for the juveniles. Specially designed barges and tanker trucks transport the young fish past the dams where they are released back into the river downstream of Bonneville Dam. This reduces their travel mortality rate for most species while maintain their biological timing for arrival at the ocean.

a. HATCHERY RELEASES. Hatchery fish released into the Columbia basin streams and rivers totaled approximately 66.7 million juvenile salmon, 10

Table 31

SUMMARY OF FISH DISPOSITION AT COLLECTOR DAMS

	CHINOOK		STEELHEAD	COHO	SOCKEYE	TOTAL
	Yearlings	Subyearlings				
LWR GRANITE						
Collected	281,665	89,608	7,322,641	1,377	3,453	4,698,744
Bypassed	1,194	1,628	107,969	29	0	110,820
Trucked	**6,809**	**85,826**	**152,336**	**439**	**1,172**	**246,582**
Barged	**269,279**	**998**	**4,026,161**	**926**	**2,162**	**4,299,526**
Total Transported	**276,088**	**86,824**	**4,178,497**	**1,365**	**3,334**	**4,546,108**
LITTLE GOOSE						
Collected	195,250	60231	1,947,986	33	1,397	2,204,897
Bypassed	104,294	222	1,439,194	0	255	1,543,965
Trucked	**2,541**	**56,413**	**23,014**	**30**	**335**	**82,333**
Barged	**81,316**	**87**	**413,223**	**0**	**625**	**495,251**
Total Transported	**83,857**	**56,500**	**436,237**	**30**	**960**	**577,584**
LWR MON'TAL						
Collected	233,530	18,712	1,672,846	290	2,278	1,927,656
Bypassed	114,519	189	1,081,123	90	934	1,196,855
Trucked	**1,562**	**18,130**	**14,081**	**108**	**916**	**34,797**
Barged	**117,186**	**2**	**577,315**	**92**	**387**	**694,982**
Total Transported	**118,748**	**18,132**	**591,396**	**200**	**1,303**	**729,779**
McNARY						
Collected	458,677	5,522,578	481,281	110,150	84,460	6,657,146
Bypassed	430,186	259,731	454,380	760,737	67,149	1,288,183
Trucked	**25,790**	**3,317,703**	**25,489**	**32,469**	**14,130**	**3,415,581**
Barged	**385**	**1,827,055**	**882**	**598**	**2,201**	**1,831,121**
Total Transported	**26,175**	**5,144,758**	**26,371**	**33,067**	**16,331**	**5,246,702**
TOTAL						
Collected	1,169,122	5,691,129	8,424,754	111,850	91,588	15,488,443
Bypassed	650,193	261,770	3,082,666	76,856	68,338	4,139,823
Trucked	**36,702**	3,478,072	**214,920**	**33,046**	**16,553**	**3,779,293**
Barged	**468,166**	1,828,142	**5,017,581**	**1,616**	**5,375**	**7,320,880**
Total Transported	**504,868**	5,306,214	**5,232,501**	**34,662**	**21,928**	**11,100,173**

These accumulated totals are from the tables listed on the internet through 10/3/1997

million less than normal and 13 million less than last year. The release of summer chinook from hatcheries on the Snake were less than normal and the spring chinook was also below normal. The release of steelhead was near normal. Limited returns from previous years reduced the number of fish returning to the hatchery for spawning.

b. COLLECTION OF JUVENILES Lower Granite, Little Goose, Lower Monumental, and McNary dams are Acollector dams@ that are equipped with submersible traveling screens, bypass facilities, and raceways capable of holding large number of fish for later transport past the dams. Operation of the fish collection facilities at Lower Granite, Little Goose, and Lower Monumental continued through October. The facilities at McNary were scheduled to operate as long as fish were present and passing the project and while conditions permitted.

It should be noted in the onset that the number of juveniles collected, bypassed, or transported is not a good indicator of the size of the juvenile fish run. Collection efficiency, spill rate and timing, and other factors all play key rolls in juvenile passage.

With the high flows this year the fish managers decided to let more of the juveniles migrate in the river, despite the higher TDG values. Although the total juveniles collected was 19% greater than in 1996 the number of fish bypassed back to the river increased by 131%. The actual counts of fish collected and bypassed is summarized in Table 31.

c. TRANSPORTATION. Barge transportation of fish on the lower Snake and Columbia rivers began in 1977 replacing most of the truck transportation, which had begun several years earlier. Transportation was initiated to reduce juvenile mortality resulting from passage through powerhouse turbines and project reservoirs. Juveniles are transported from upstream collector projects to a location downstream of Bonneville, the most

Table 32

JUVENILE FISH TRANSPORT BY PROJECT, 1978-97

YEAR	LOWER GRANITE	LITTLE GOOSE	LOWER MONUMENTAL	McNARY	TOTAL
1978	1,980,600	997,285		82,211	3,059,906
1979	2.367,446	1,453,615		1,247,120	5,068,181
1980	3,830,747	2,282,987		1,740,545	7,854,279
1981	2,730,866	1,464,991		4,112.993	8,308,850
1982	1,851,616	1,234,110		3,003,853	6,089,579
1983	2,368,049	868,937		4,326,013	7,562,999
1984	2,046,020	2,274,307		4,708,632	9,028,959
1985	4,459,438	2,008,980		8,321,649	14,790,067
1986	4,683,260	2,050,130		6,760,421	13,493,811
1987	5,470,751	1,910,026		9,655,789	17,036,566
1988	7,504,860	1,708,401		10,820,592	20,033,853
1989	6,703,360	2,310,458		6,364,143	15,377,971
1990	9,336,878	2,319,978		9,789,733	21,446,589
1991	8,420,639	2,245,587		4,808,476	15,474,702
1992	6,766,364	1,777,940		8,997,836	17,542,140
1993	7,577,782	1,325,364	955,195	5,205,420	15,063,761
1994	6,839,755	1,453,818	1,410,024	5,750,590	15,456,181
1995	9,058,442	2,400,917	1,657,567	5,435,658	18,552,584
1996	5,136,914	1,879,029	1,264,057	2,907,322	11,187,340
1997	4,546,108	557,584	729,779	5,246,702	11,100,173

Note: Lower Monumental began counting transport in 1993.

downstream dam.

This year the juvenile transport season began oi March and ended in October at Lower Granite, Little Goose, and Lower Monumental. Collection facilities at McNary remained in operation as long as juvenile fish continued to arrive at the project or until the facilities had to be closed for safety. In general trucking was limited to periods when daily collection was less than 20,000 fish per day. The total count of juveniles listed by transport mode and project is given in Table 32.

The total number of fish transported by barge and truck remained virtually the same as last year, although the numbers from the Snake collector projects were lower than last year they were higher at McNary on the Columbia River. The highest count was in 1990 while 1995 was third highest.

4. Adult Runs

Adult fish counts were obtained at twelve of the thirteen mainstream Columbia and Snake river dams that have fish passage facilities. Although many species were counted (Table 33) only the salmonid races and species counts at three major dams are reported, with their 10-year averages and with the counts of the past five years. The difference between the McNary and Ice Harbor counts is an index to the mid-Columbia return.

Most species showed increases over the previous year's counts, with only fall chinook and steelhead counts at Ice Harbor and McNary lower than in 1996. Returning spring chinook doubles their 1996 count at Bonneville, tripled the return at McNary and increased more than five-fold at Ice Harbor. Summer chinook responded similarly with increases of 66% at Bonneville, 45% at McNary and 132% at Ice Harbor. The counts of fall chinook and steelhead were mixed with 7.5% increases for both at Bonneville while both species counts decreased at McNary and Ice Harbor: 7.5% and 15.5% at McNary and 17% and 21% at Ice Harbor. The big winners, however, were the coho and sockeye at Ice Harbor which increased from 10 to 64 and one to 16, respectively.

H. SPECIAL OPERATIONS

1. Vernita Bar

As in the past, flows were provided at Vernita Bar to

Table 33

YEARLY ADULT FISH COUNTS

							10-Year Average	Last Higher Year
BONNEVILLE	**1997**	**1996**	**1995**	**1994**	**1993**	**1992**		
Spring Chinook	**115,034**	56,433	9,846	20,566	112,172	90,582	73,322	'86
Summer Chinook	**29,863**	17,989	15,325	19,531	23,616	19,245	25,463	'89
Fall Chinook	**238,314**	221,524	164,686	203,353	141,622	146,104	229,449	'89
Coho	**24,423**	18,455	12,009	22,894	11,457	16,553	21,659	'91
Steelhead	**251,384**	234,040	230,258	161,978	187,972	312,833	234,183	'92
Sockeye	**46,927**	29,037	8,719	12,678	80,178	84,998	58,150	'93
McNARY								
Spring Chinook	**57,236**	17,683	5,572	9,007	59,556	50,504	35,756	'93
Summer Chinook	**22,351**	15,406	13,200	14,313	20,374	14,414	19,093	'89
Fall Chinook	79,412	81,562	92,443	105,568	63,428	70,688	91,324	'96
Coho	**2,482**	1,842	997	1,735	460	1,804	1,121	'89
Steelhead	118,866	140,749	127,065	94,427	93,280	203,341	102,578	'96
Sockeye	**37,560**	28,584	8,320	10,601	66,484	68,732	46,041	'93
ICE HARBOR								
Spring Chinook	**40,352**	7,466	1,719	3,472	24,935	26,114	17,953	pre '84
Summer Chinook	**9,318**	4,018	903	1,003	6,919	4,378	4,797	pre '84
Fall Chinook	3,908	4,699	5,204	3,133	3,141	5,531	3,990	'96
Coho	**64**	10	4	1	1	0	0	pre '84
Steelhead	84,311	107,099	90,573	51,704	73,101	160,637	64,121	'96
Sockeye	**16**	1	3	0	18	30	11	'93

NOTES: 1. Adult and jack counts for chinook and coho are combined. 2. Data source: Fish Passage Center internet publications.
3.Data is preliminary. **4. Bold** typeface shows increase over 1995.

encourage fall chinook spawning at low elevations in the channel as required by agreement between Grant County PUD and the Federal Energy Regulatory Commission. During mid-October through late November, daytime discharges at Priest Rapids were kept below 50 kcfs as much as possible to minimize redd building above that level on Vernita Bar. This was accomplished by reverse load factoring at the project, with reduced power generation during daylight hours and higher generation at night to pass the daily average inflow.

2. <u>Libby Arrow Swap</u>.

The Canadian and United States entities of the Columbia River Treaty Operation Committee entered into an agreement to store and release water in Libby and Arrow reservoirs in an optimal manner. They agreed to store water in Libby during August 1-31, 1997 and return water to Arrow between September 1, 1997 and January 16, 1998. This arrangement was desirable to the United States because instead of releasing salmon augmentation water (as required by the Biological Opinion) from Libby in August, the water was released in the fall and winter months and the Libby reservoir could remain high for summer recreation. This arrangement was desirable to Canada for two reasons. The first one being that Libby Reservoir backs up into Canada, and a higher Libby reservoir in August means better summer recreation in Canada also. The second reason is because Arrow Lakes released more water than normal in August, releases in the fall/winter period were lower than normal. Lower fall/winter flows were preferred because this encouraged whitefish to spawn at lower levels and the eggs would be more likely to stay submerged/safe until they hatched.

The amount of water swapped between Libby and Arrow reservoirs was about 380 kaf (190 ksfd). This resulted in Libby being drafted to 2450.12 ft at the end of August instead of 2439.0 ft as called for in the Biological Opinion.

Near **Thousand Springs Powerhouse**. Ron Abramovich, NRCS, explains how artificial wetlands, with selected nutrient-hungry vegetation, are being used to upgrade the quality of the used irrigation flow being returned to the river.

Endangered Snail Study. Within easy walking distance of the Thousand Springs powerhouse is the snail in-field work site for endangered mollusca. Five species of mollusca (snails) found in this area have been listed under the ESA as either threatened or endangered. Approval for up grading of Thousand Springs hinges on the outcome of this study.